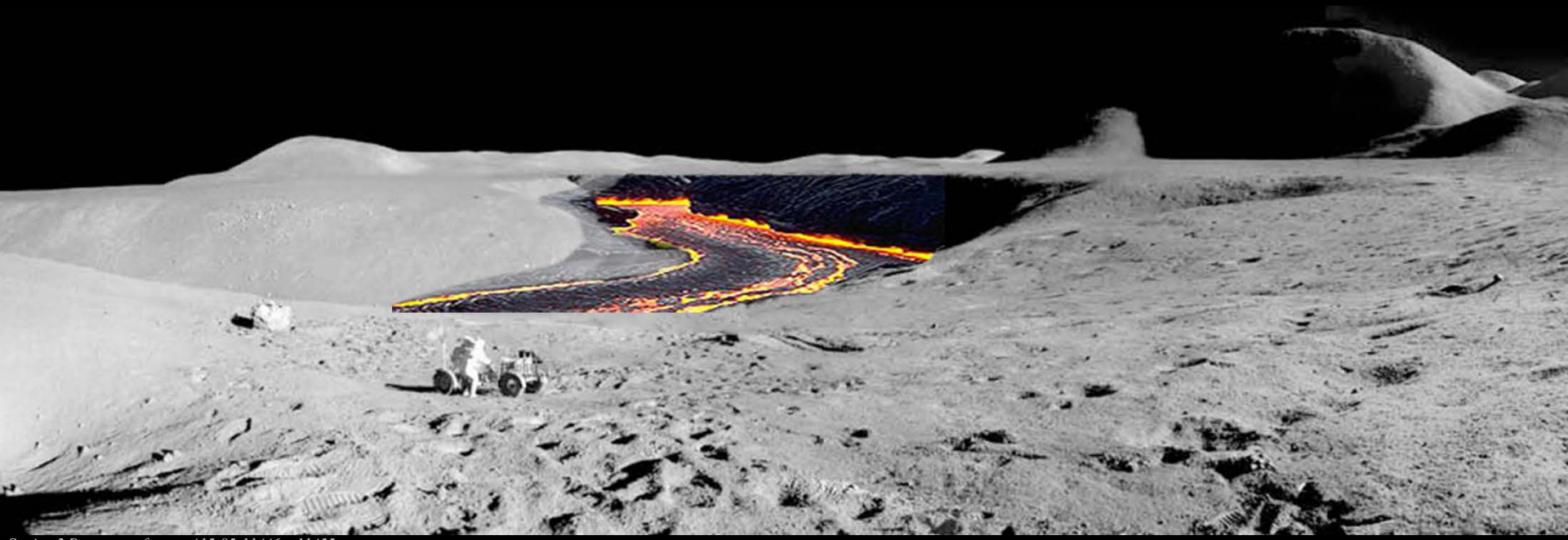
Lava Eruption and Emplacement:

Using Clues from Hawaii and Iceland to Probe the Lunar Past



Station 2 Panorama, frames A15-85-11446 – 11455.

Debra Hurwitz Needham
NASA Marshall Space Flight Center

C.W. Hamilton, J.E. Bleacher, P.L. Whelley, K.E. Young,
S.P. Scheidt, J.A. Richardson, S.S. Sutton

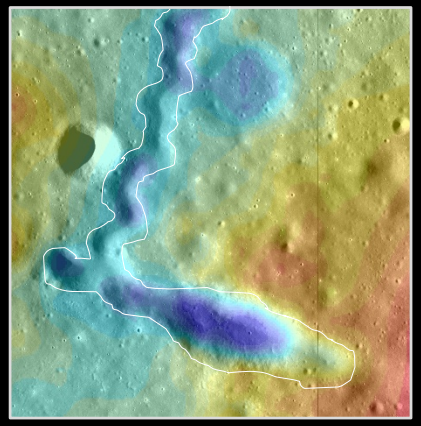
Lunar and Planetary Science Conference March 22,, 2017

Talk Overview

- Introduction to the Lunar Sinuous Rille Rima Bode.
  - Location and morphology.
- Origin of the Vent and Channel.
  - Clues from Holuhraun, Iceland's 2014/2015 eruption.
- Origin of the Channel and Down-Channel Feature.
  - Clues from Kilauea, HI's December 1974 eruption.
- Lessons Learned for Rima Bode.

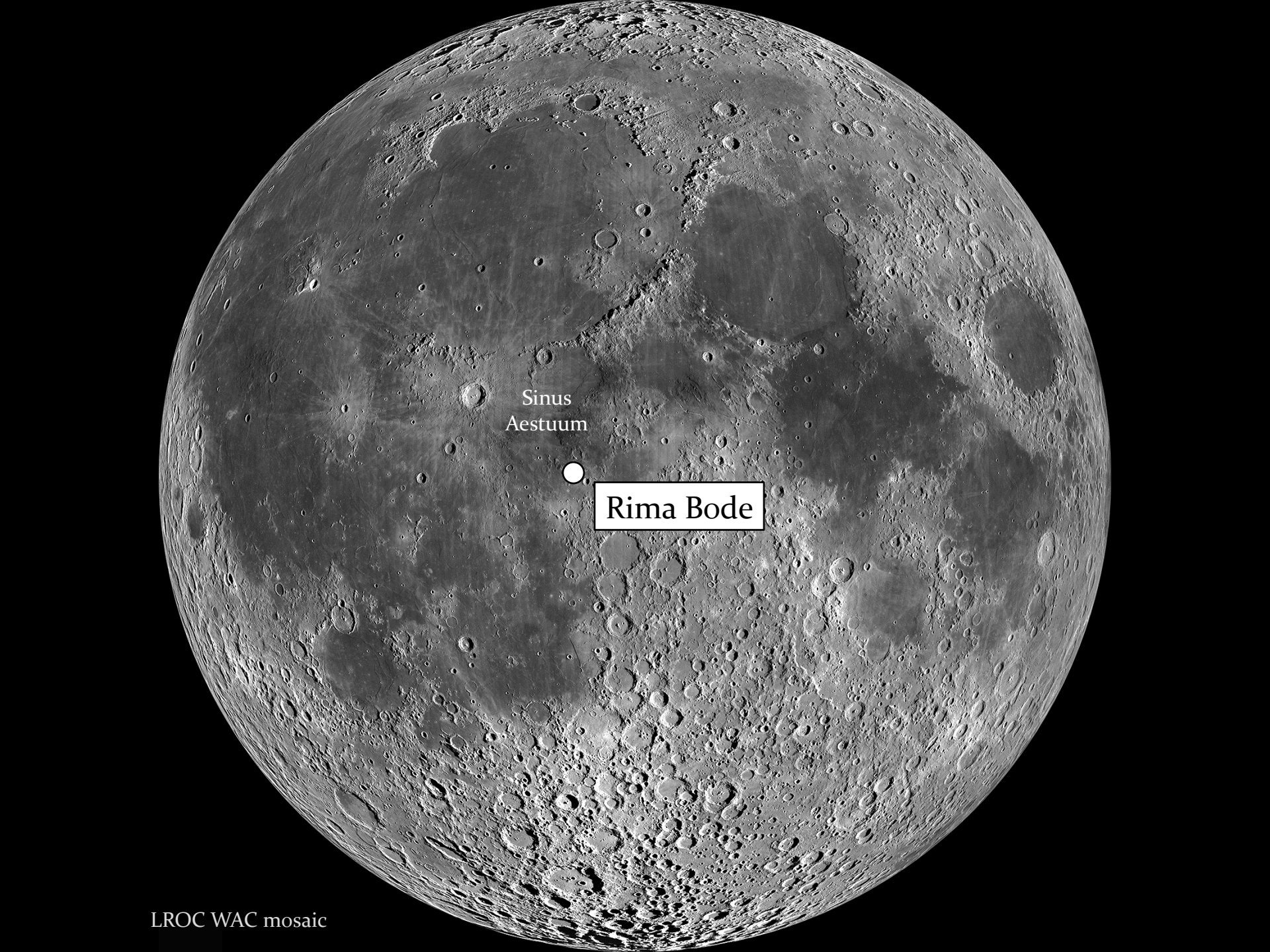
The 2014/15 Holuhraun eruption.
Dađi Harđarson ©Nýjar viddir, with permission

The Dec. 1974 Kilauea lava flow. *Photo by Needham.*



Rima Bode, Moon.
Kaguya TC image.

Rima Bode, Moon

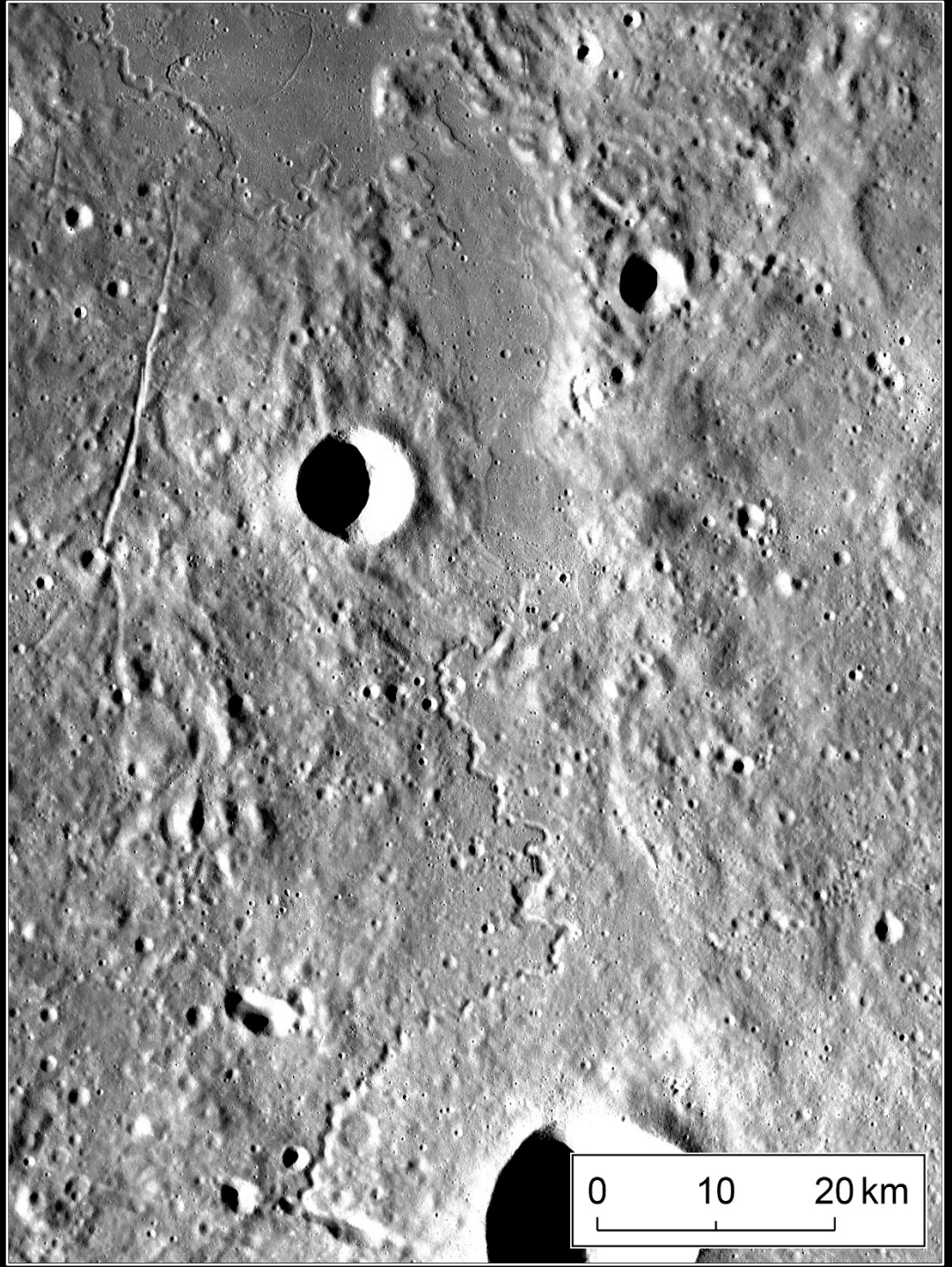

Sinus
Aestuum
Rima Bode
LROC WAC mosaic

Rima Bode:

Channel Length
- 109 km (upper), 139 km (lower).

Channel Width
- 870 m (upper), 670 m (lower).

Channel Depth
- 100 m (upper), 75 m (lower).



Kaguya TC mosaic

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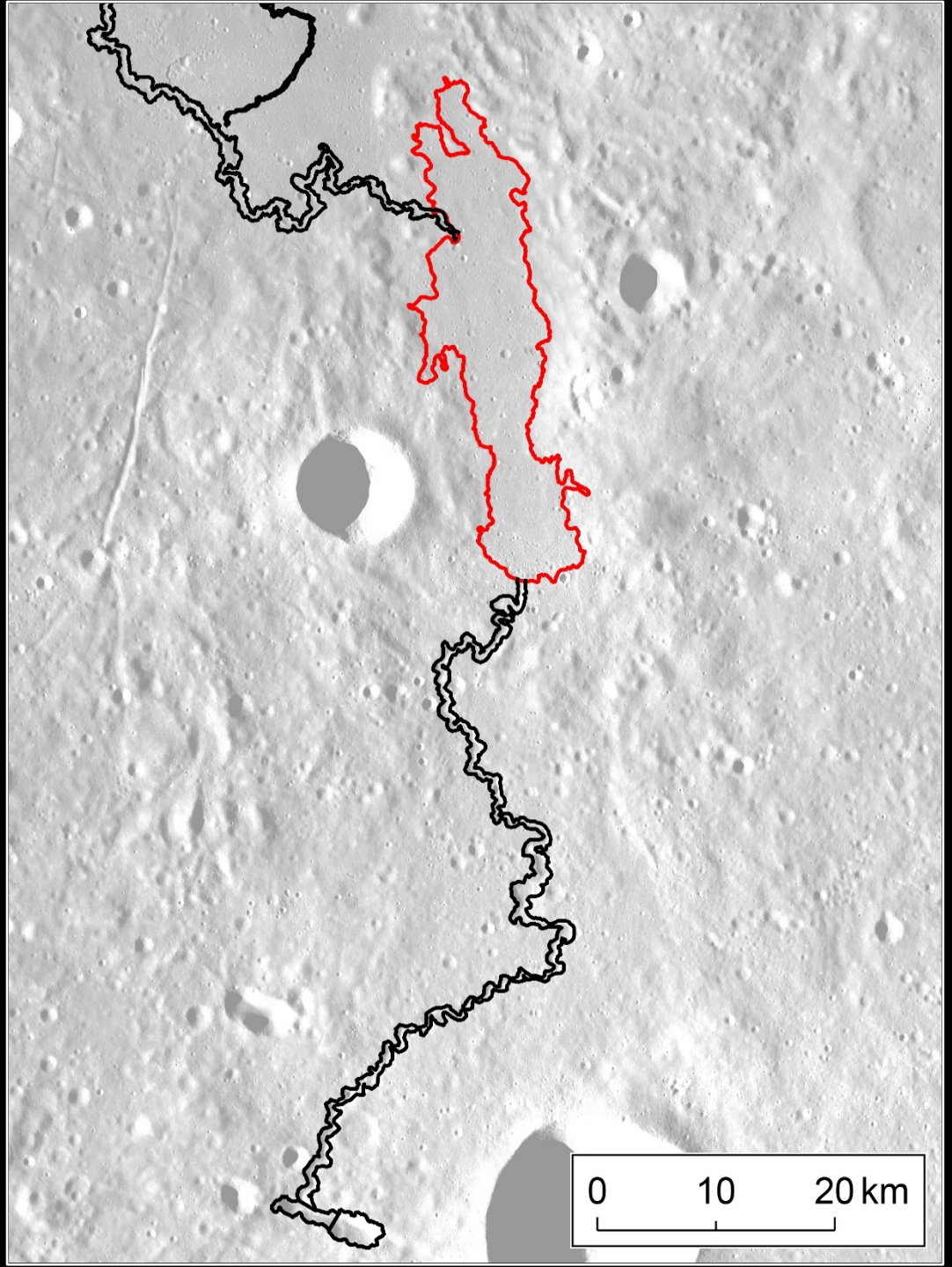

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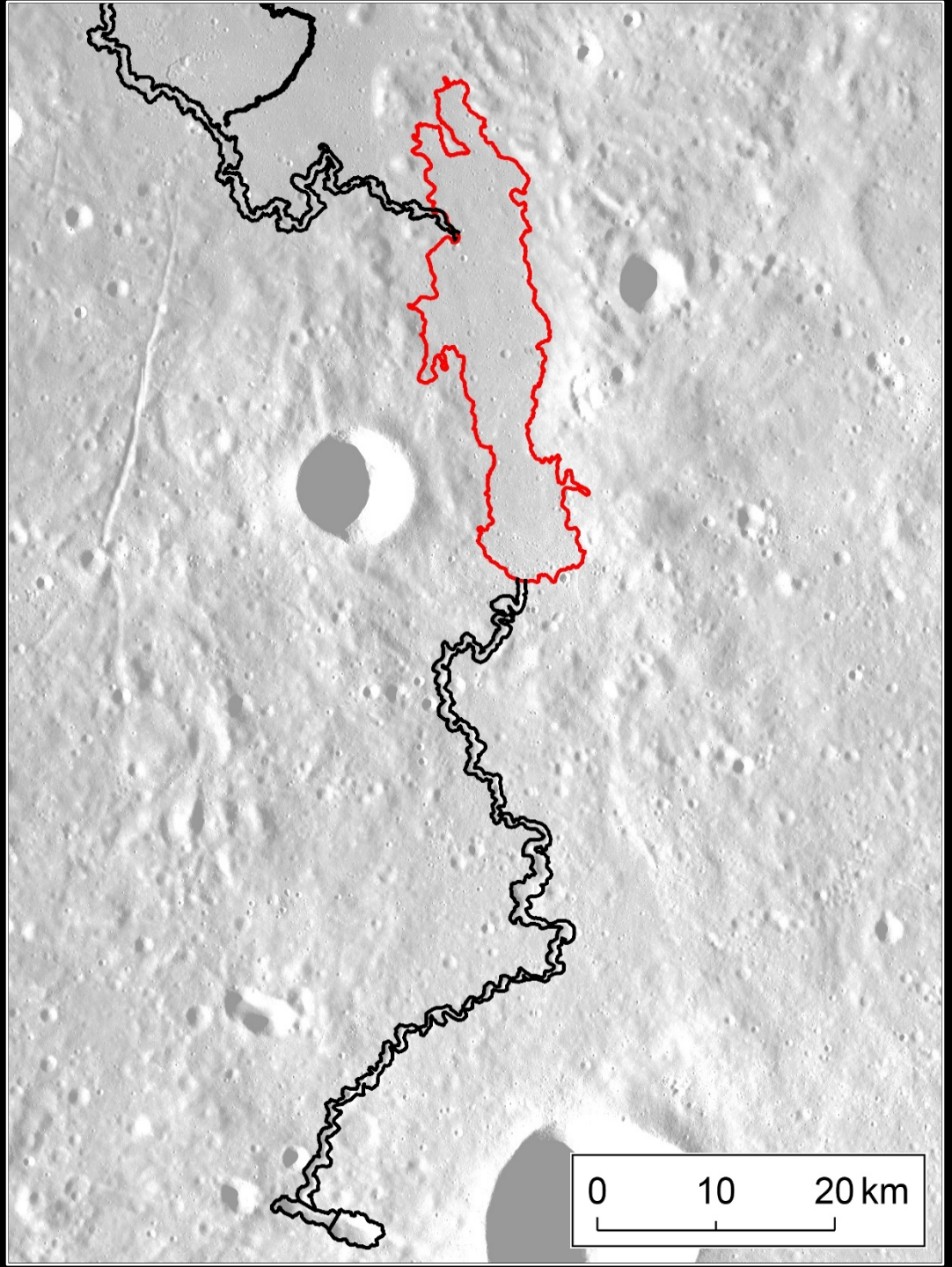


How did the channel develop?

What separates the two channel segments?

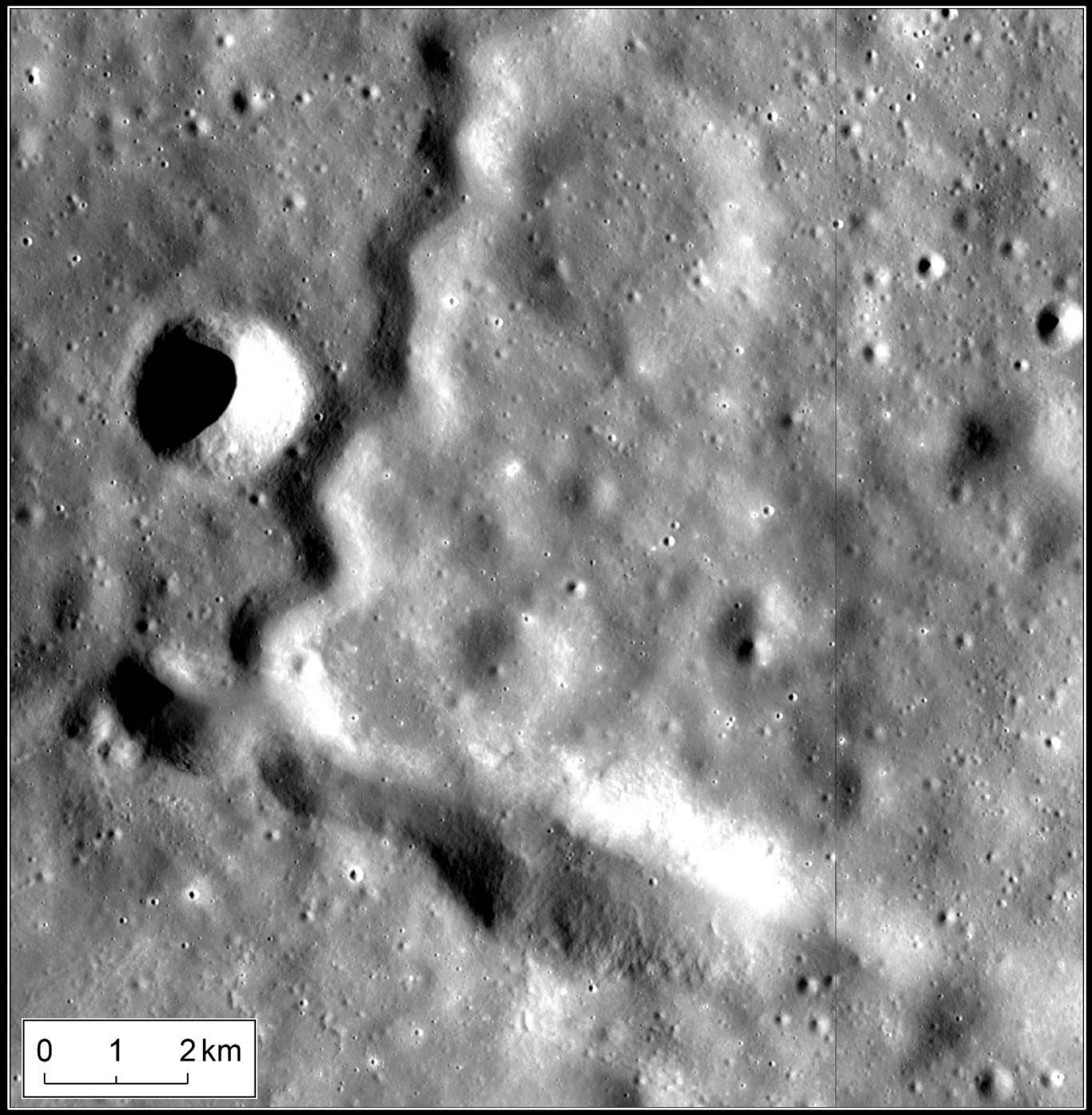
Kaguya TC mosaic

Rima Bode:

Vent Area
- 15 km^2.

Vent Depth
- 406 m (160–500 m).

Vent Volume
- 6 km^3.



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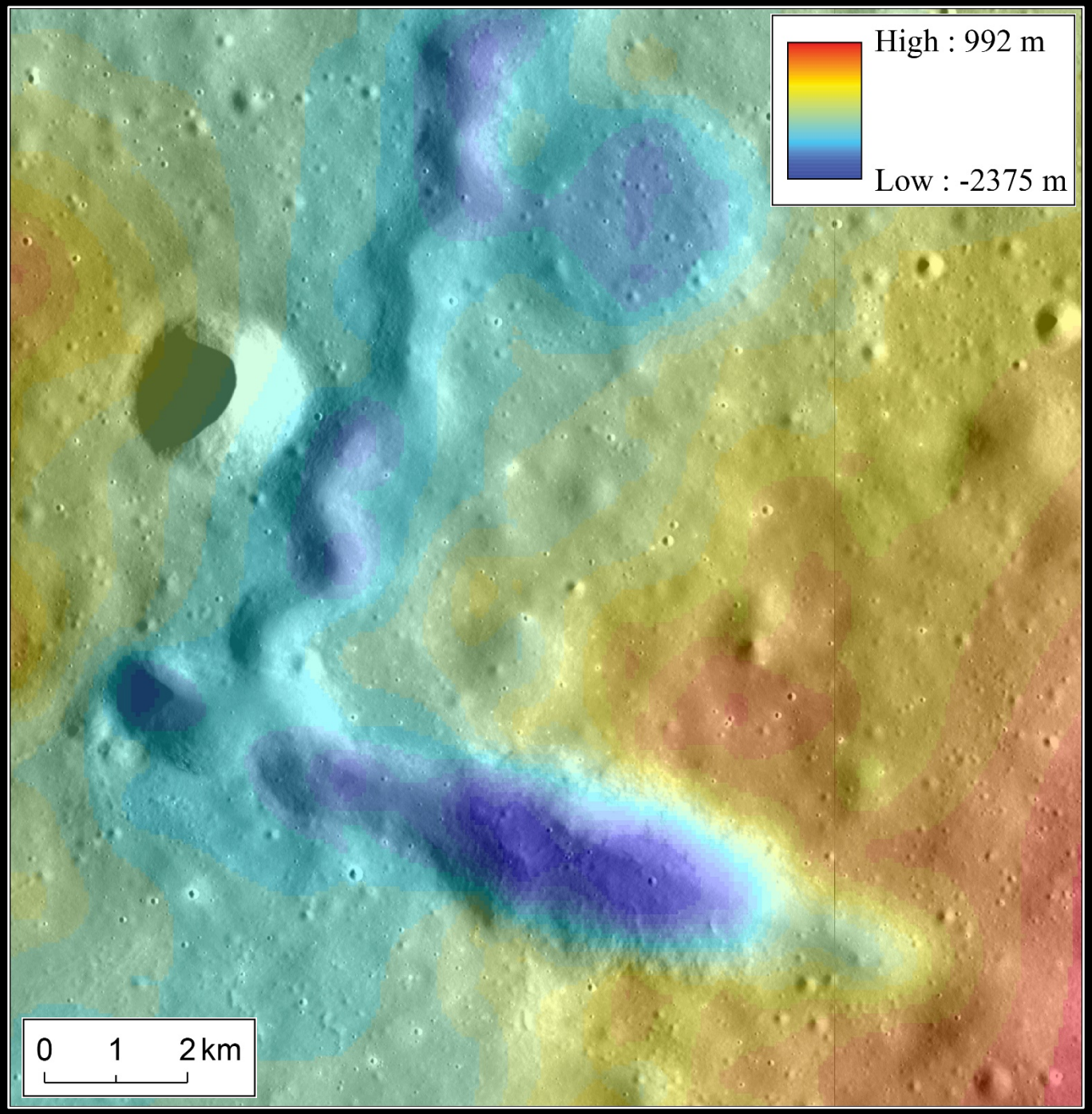

LOLA topography

Rima Bode:

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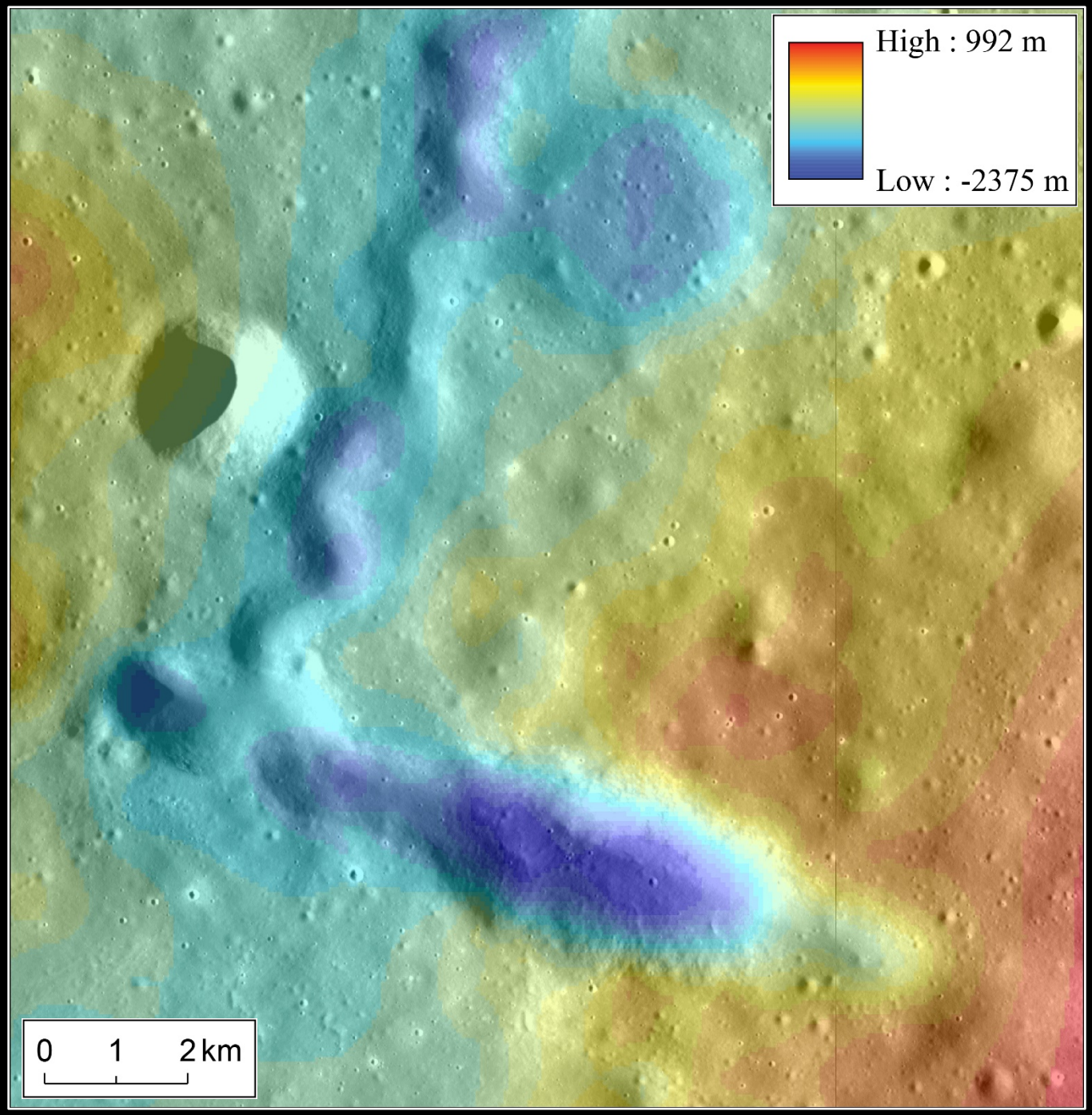
What is the origin of the circular vent features?

How did the channel develop?

Did lava pool in the vent before forming the channel?



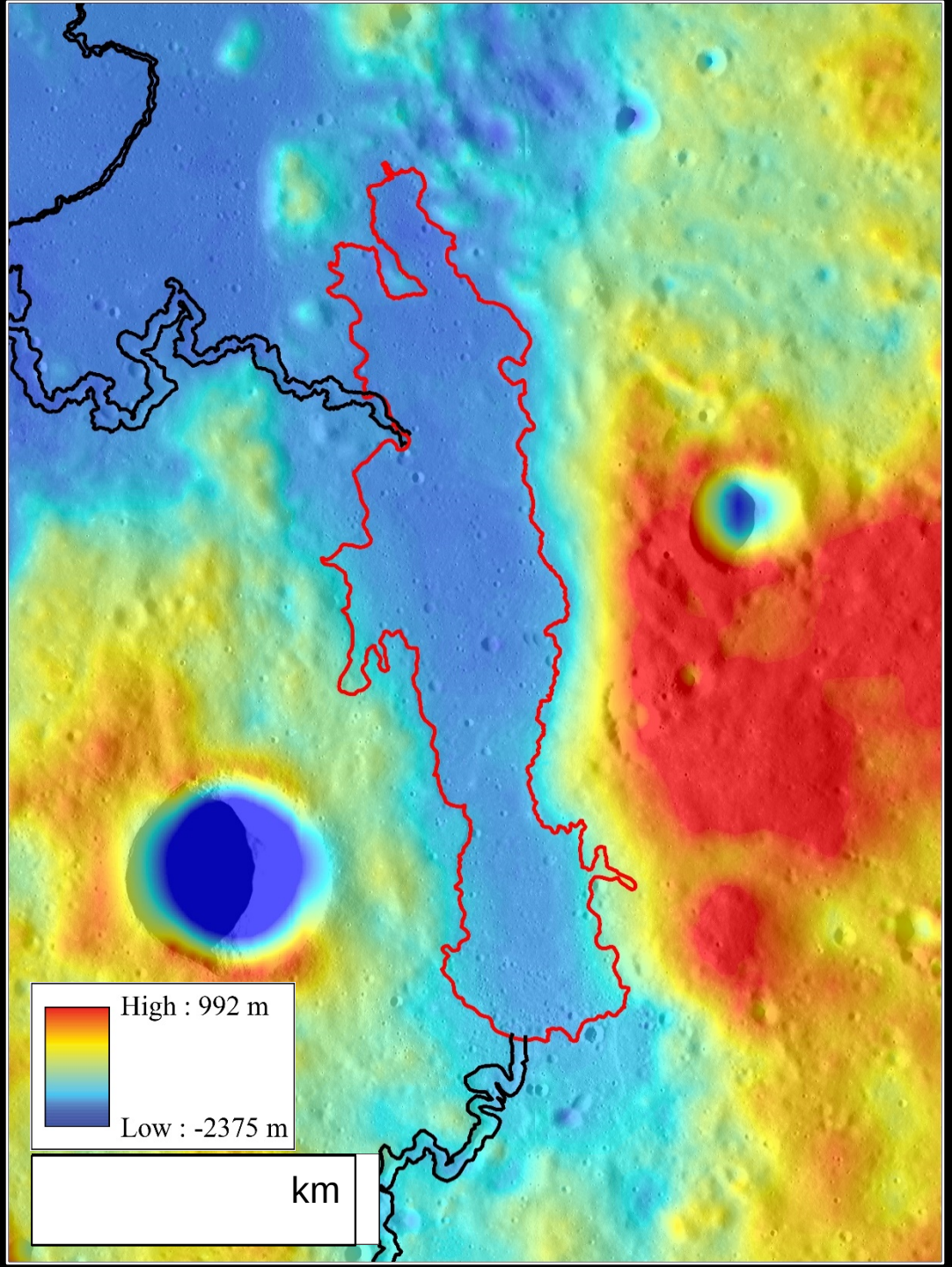
LOLA topography

Rima Bode:

Feature Area
- 266 km^2.

Feature Depth
- ~60 – 80 m.

Feature Volume
- 14 km^3.



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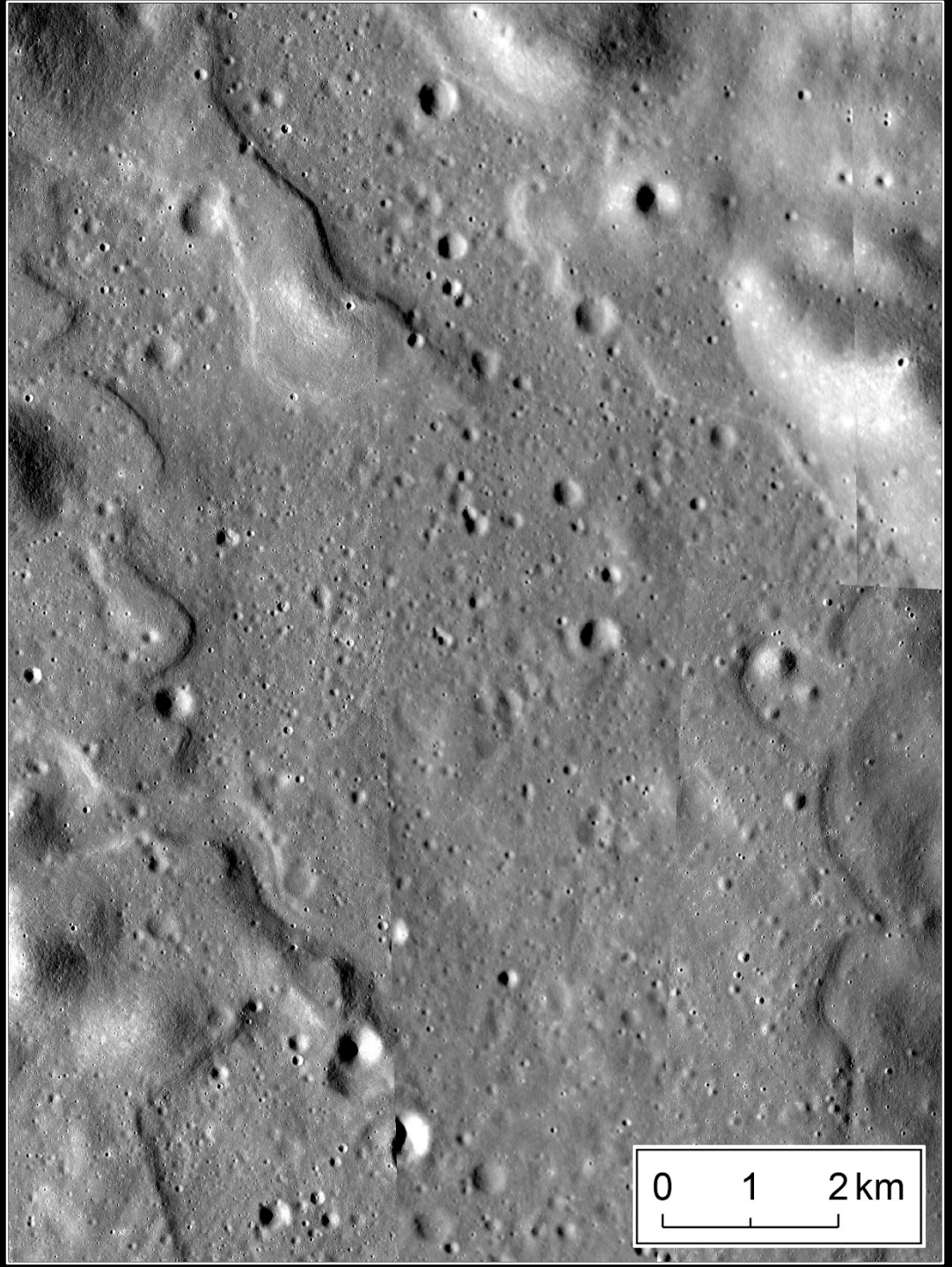

LROC NAC images and Kaguya TC mosaic

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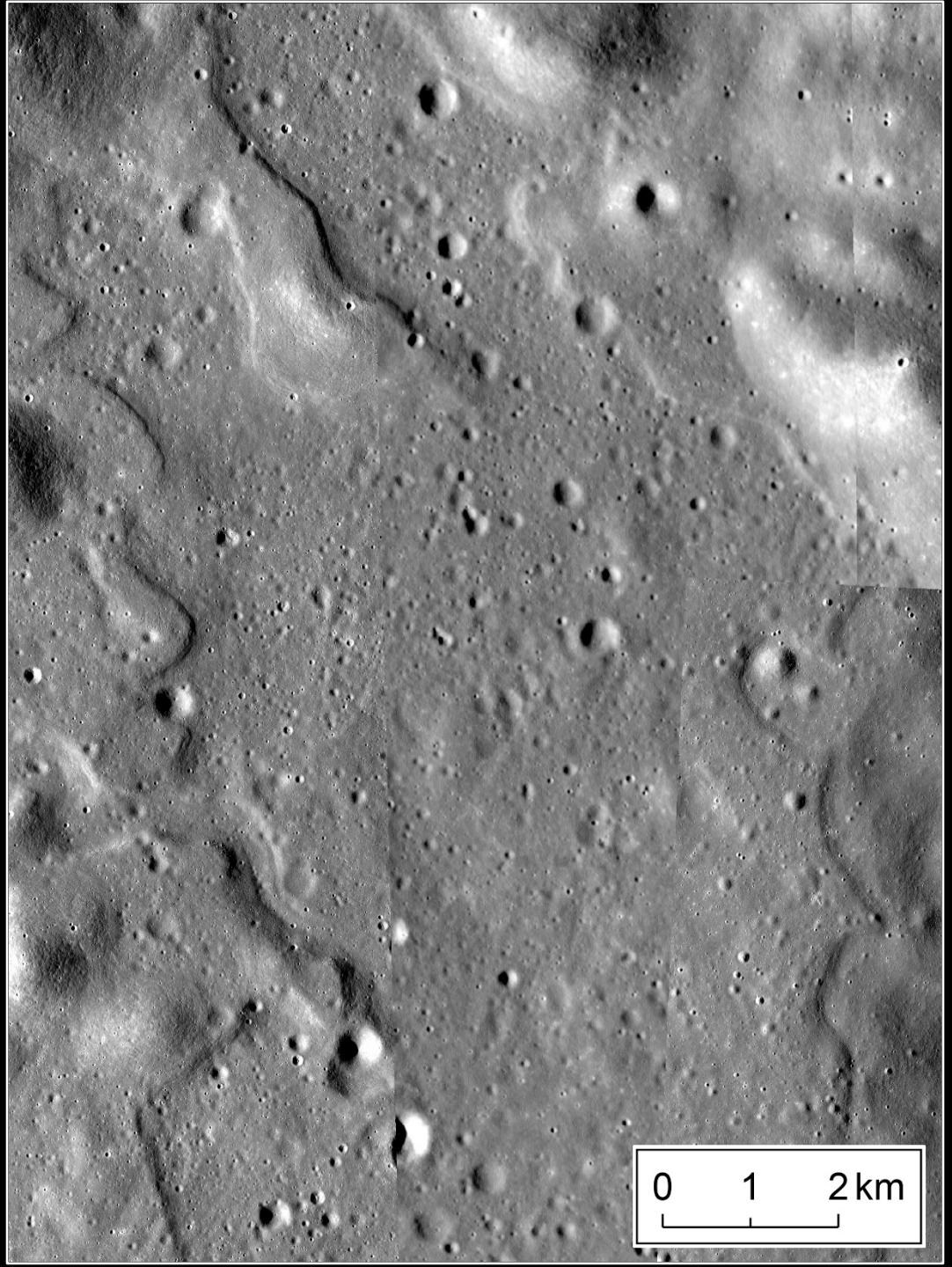
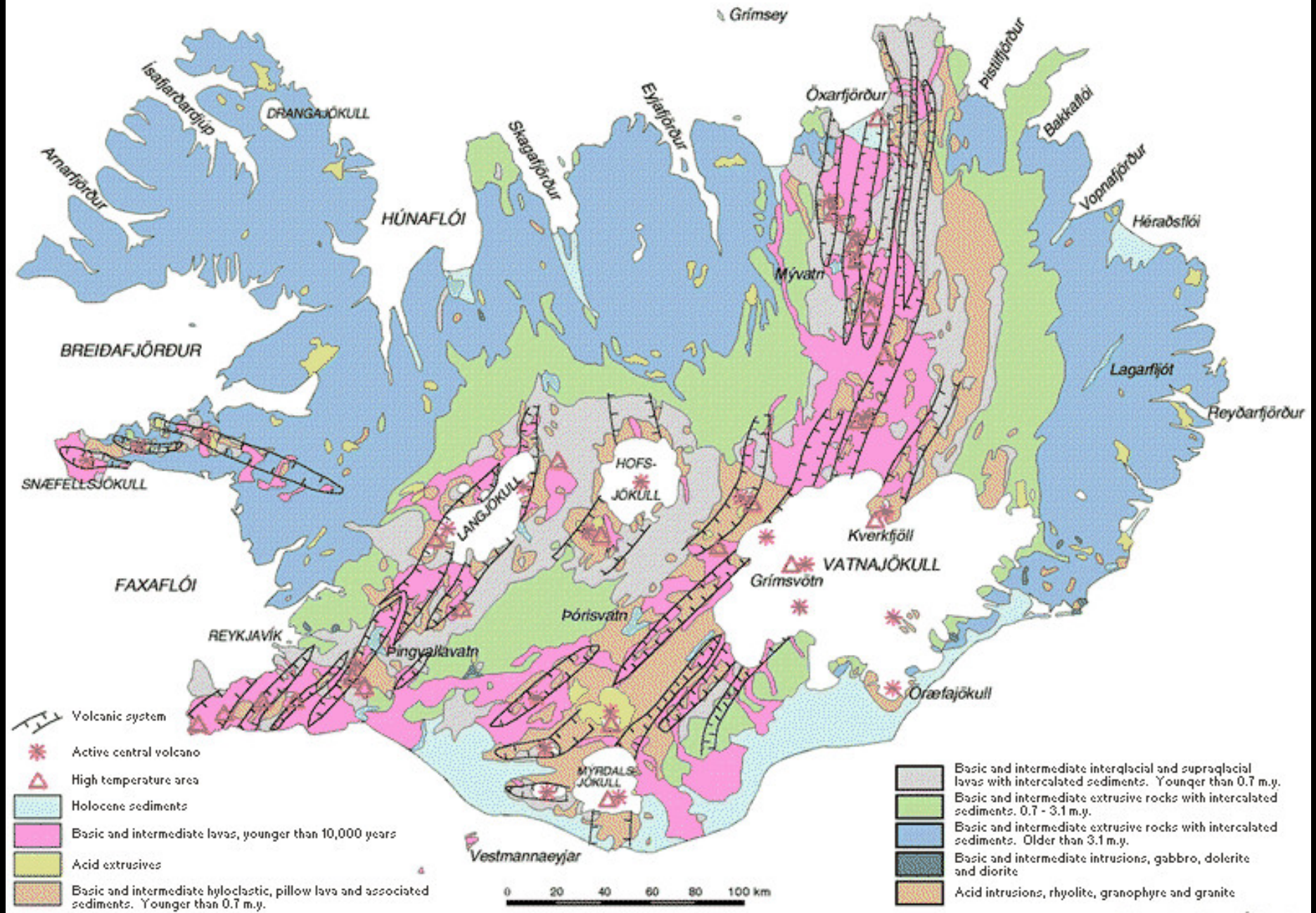


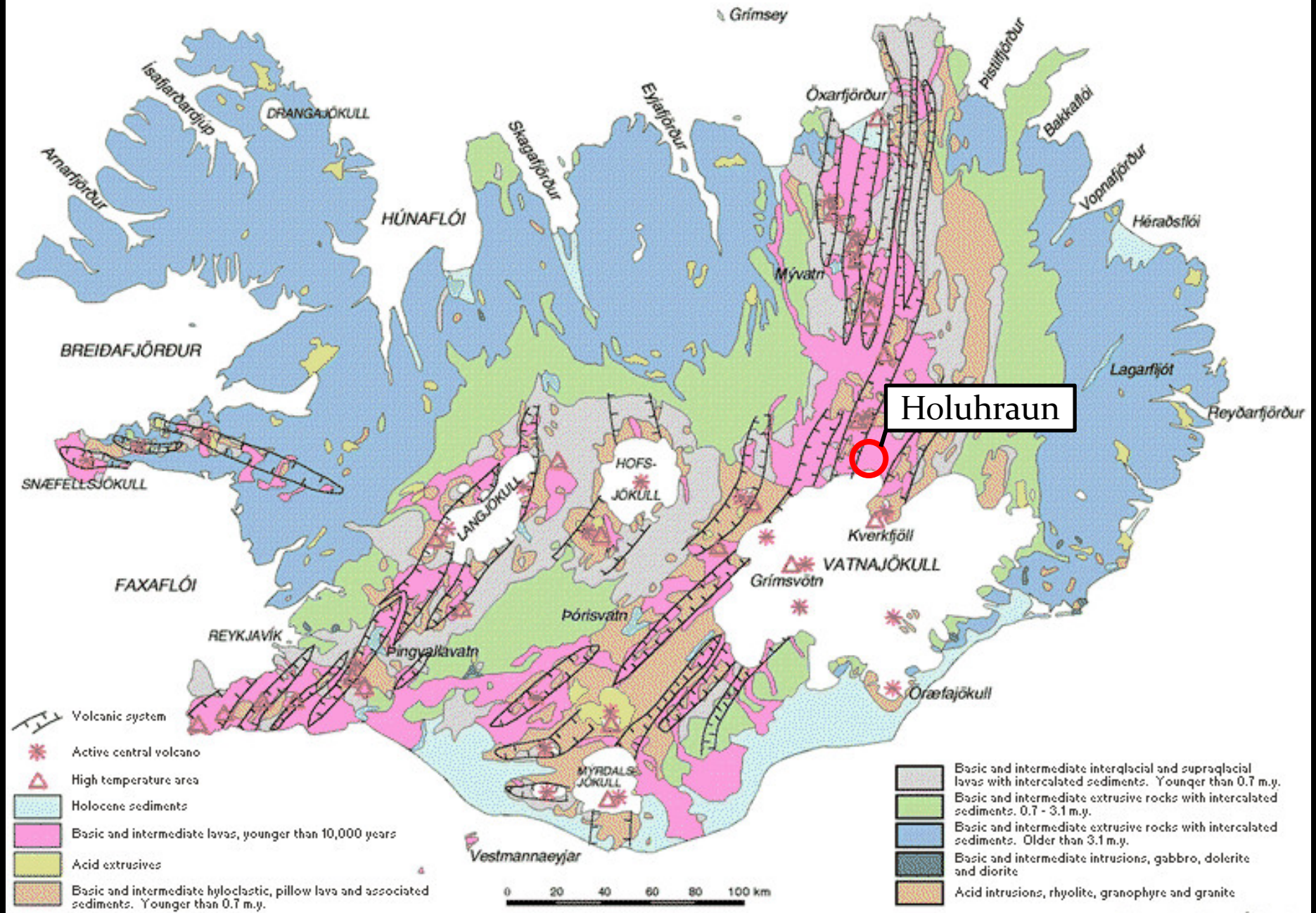
What is this feature, and how did it form?

LROC NAC images and Kaguya TC mosaic

2014-15 Holuhraun Eruption, Iceland



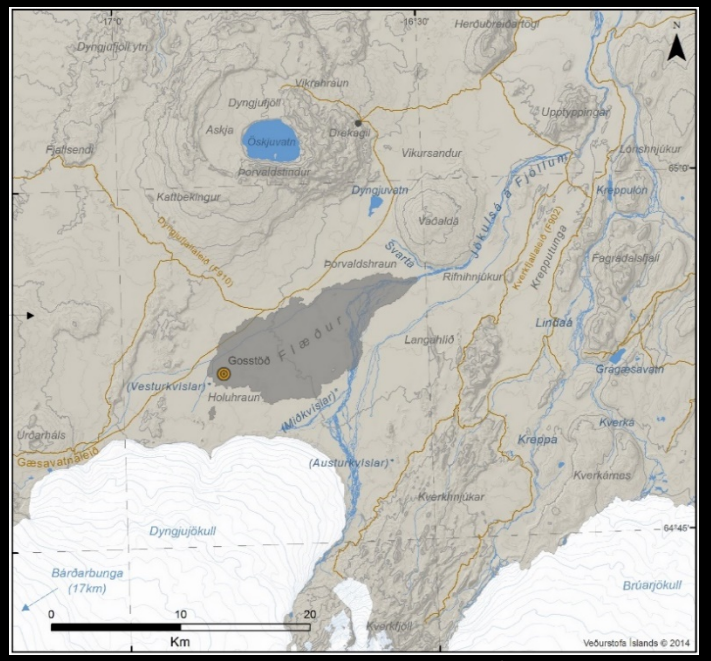
National Land Survey of Iceland © Landmælingar Íslands



National Land Survey of Iceland © Landmælingar Íslands

Holuhraun Eruption

- August 29, 2014 – February 27, 2015.
  - Duration of 183 days.
- Areal Extent: 85 km^2.
- Volume: 1.6 km^3.
- Mean Eruption Flux: 161 m^3/s *(Gouhier et al., 2015)*



Veðurstofa Íslands, Icelandic Meteorological Office

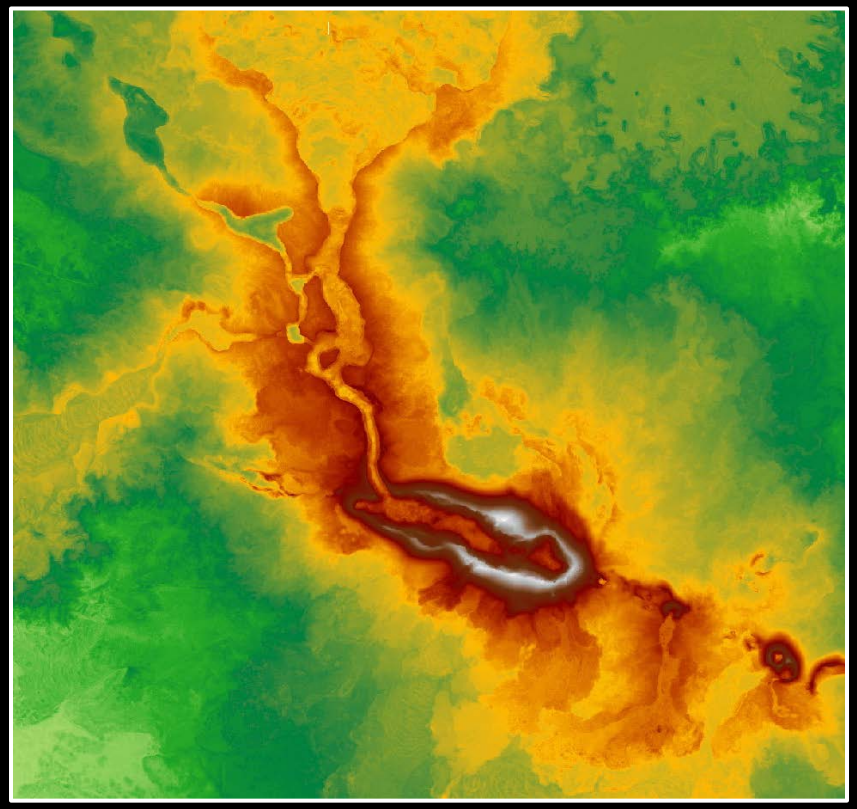
Eruption circa September, 2014.
Photo by Mýflug Air.

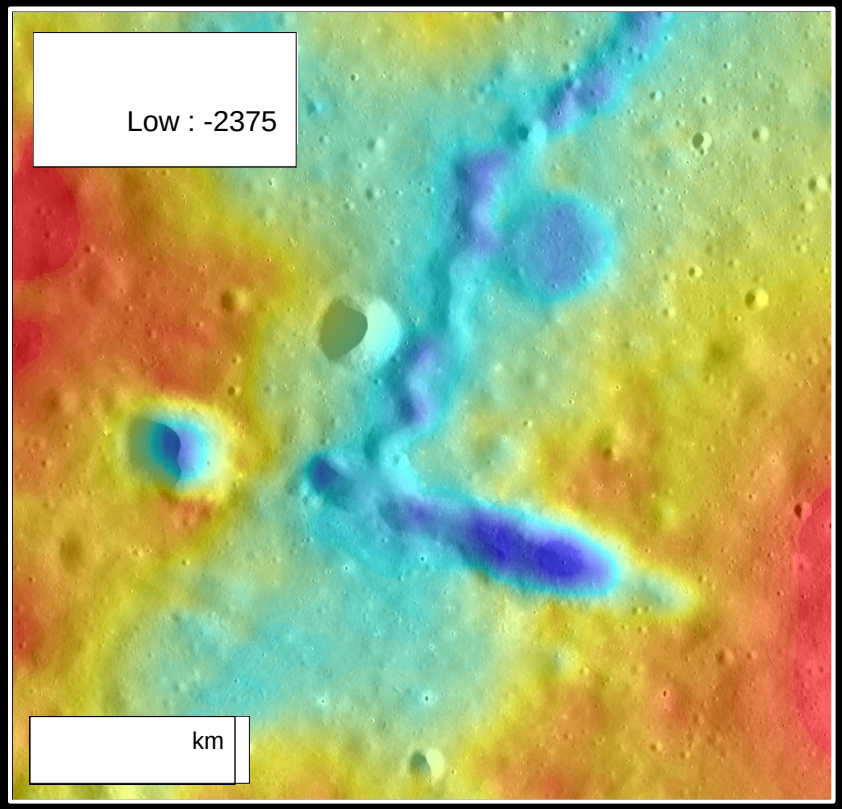
Eruption circa late 2014.
Dađi Harđarson ©Nýjar viddir

Eruption circa February 2015.
Photo by Gísli Gíslason/Norđurflug Helicopter Tours.

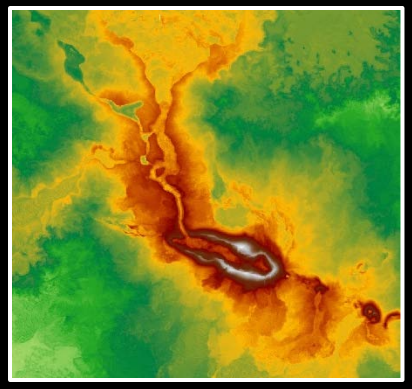
https://youtu.be/aAnuMD9TYl4

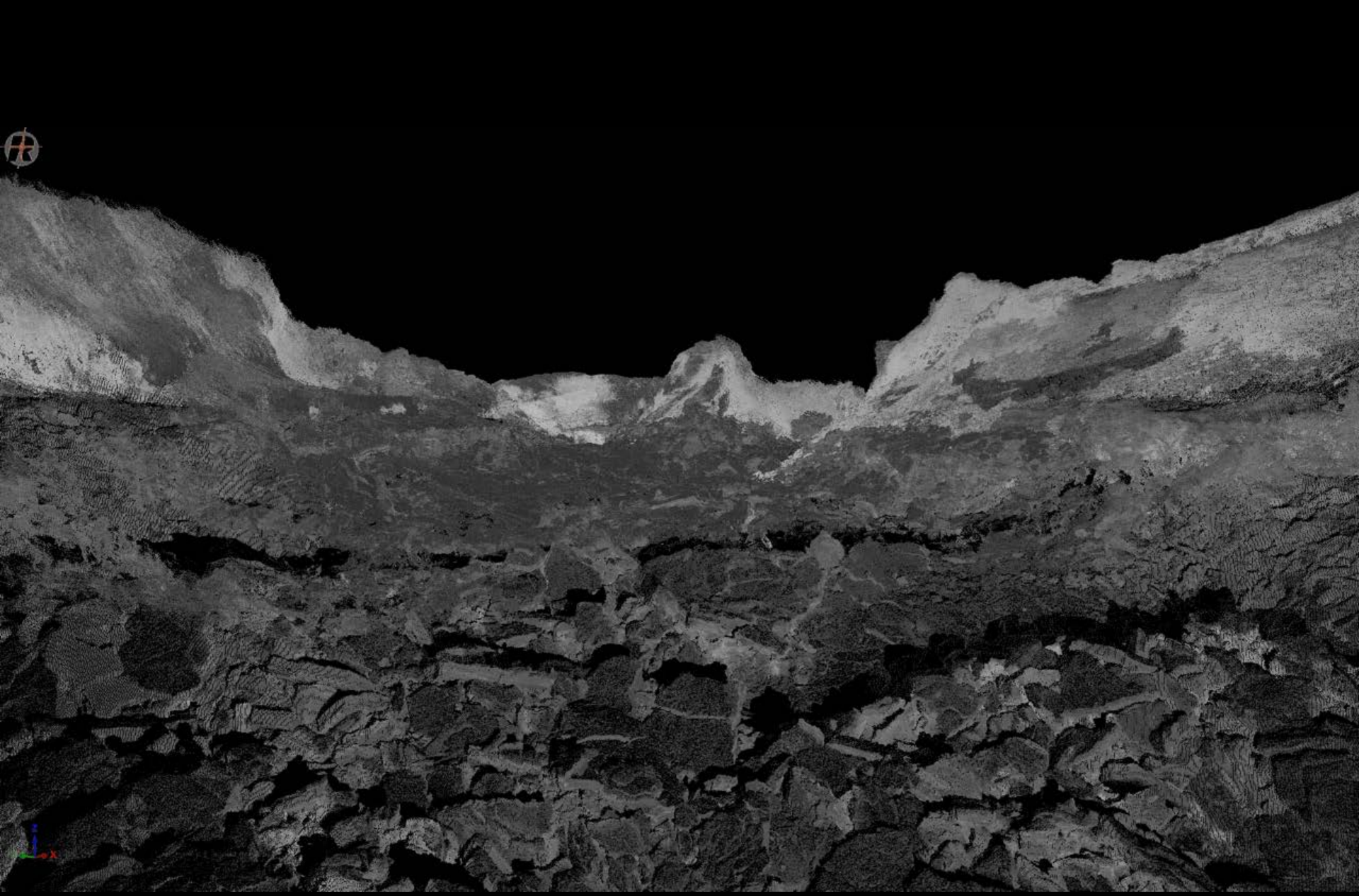
Video by dricx1.

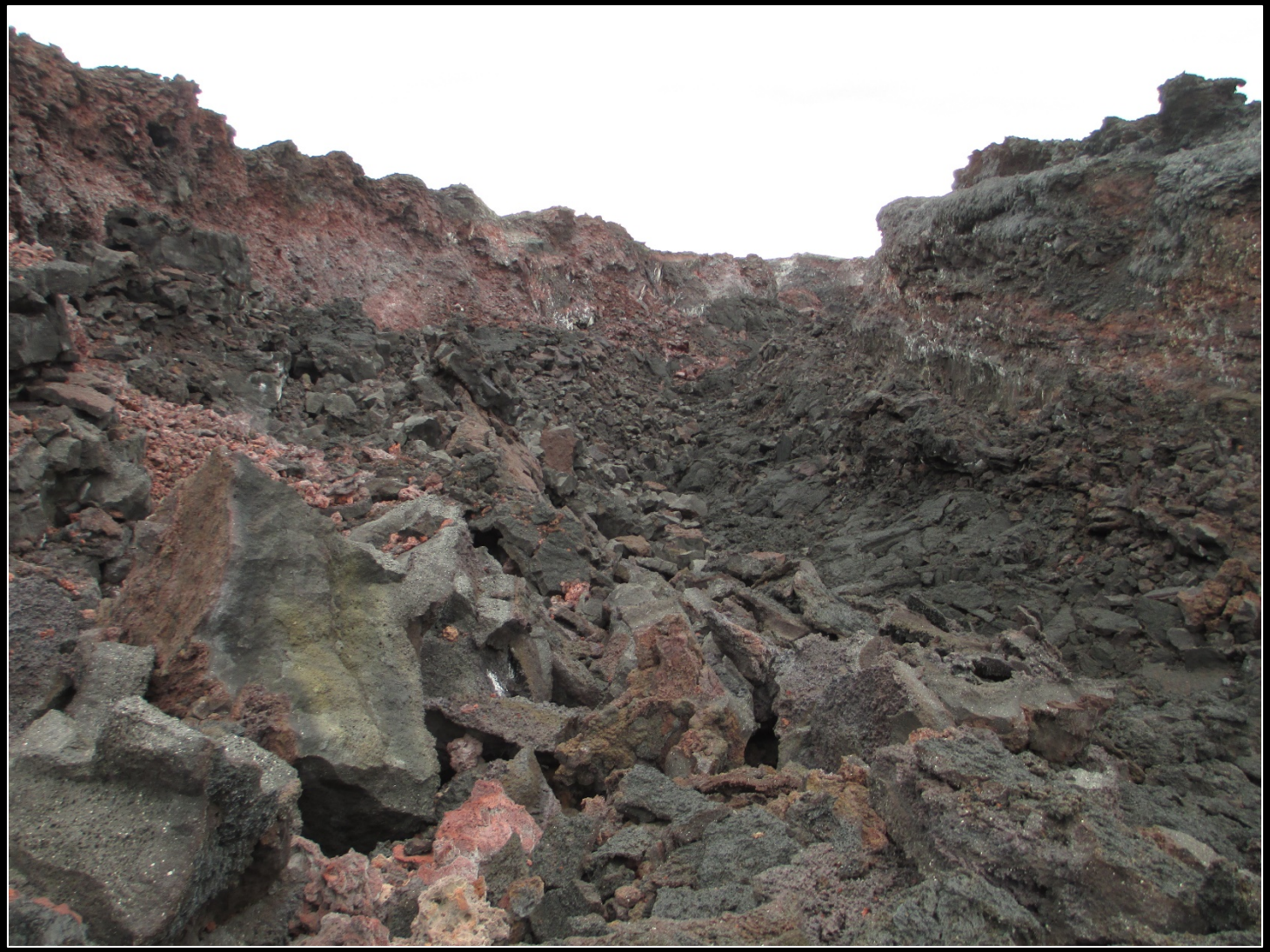




LOLA topography







Conclusions 1: Channel Initiation

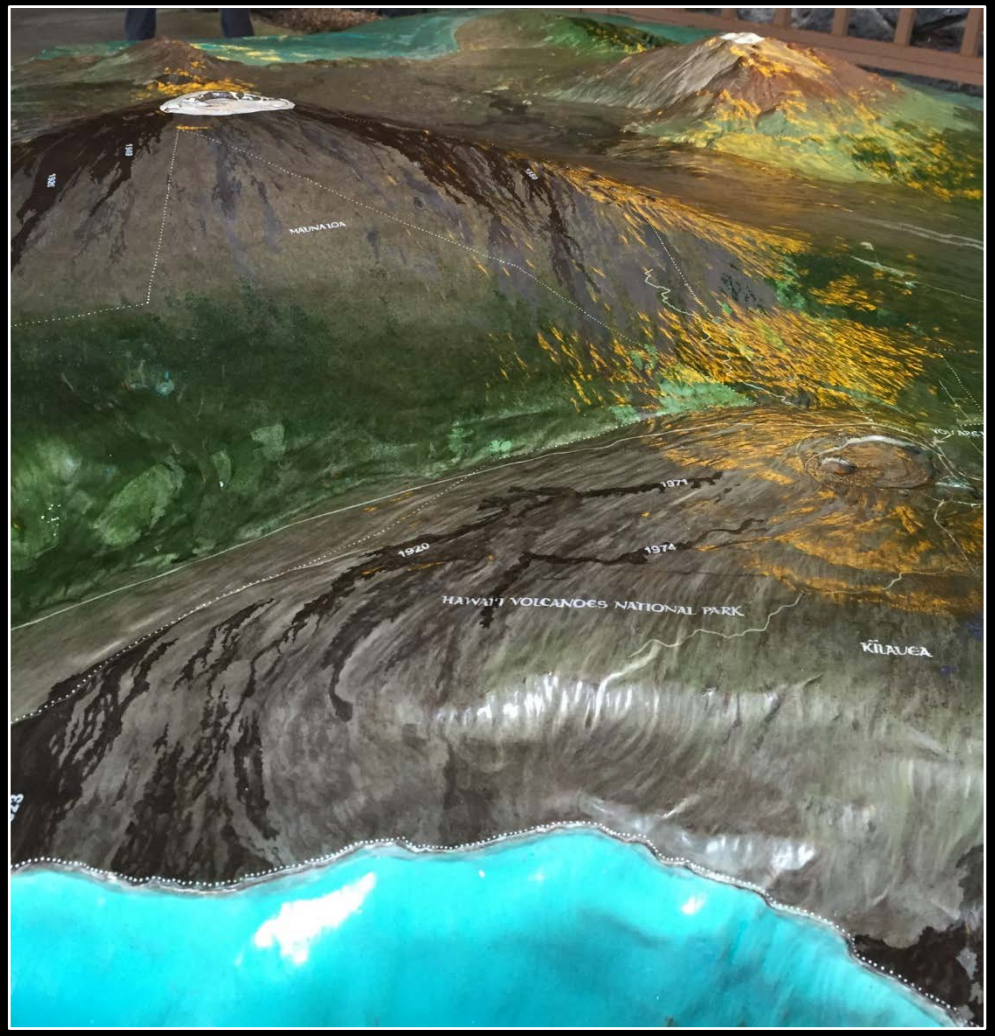
- Rare opportunity to compare active eruption with post-eruption flow morphology.
- Channel initiated early, as the vent developed around it.
- Minor amounts of mechanical erosion may occur locally.

Dađi Harđarson ©Nýjar viddir

Dec. 1974 Eruption, Kilauea, HI

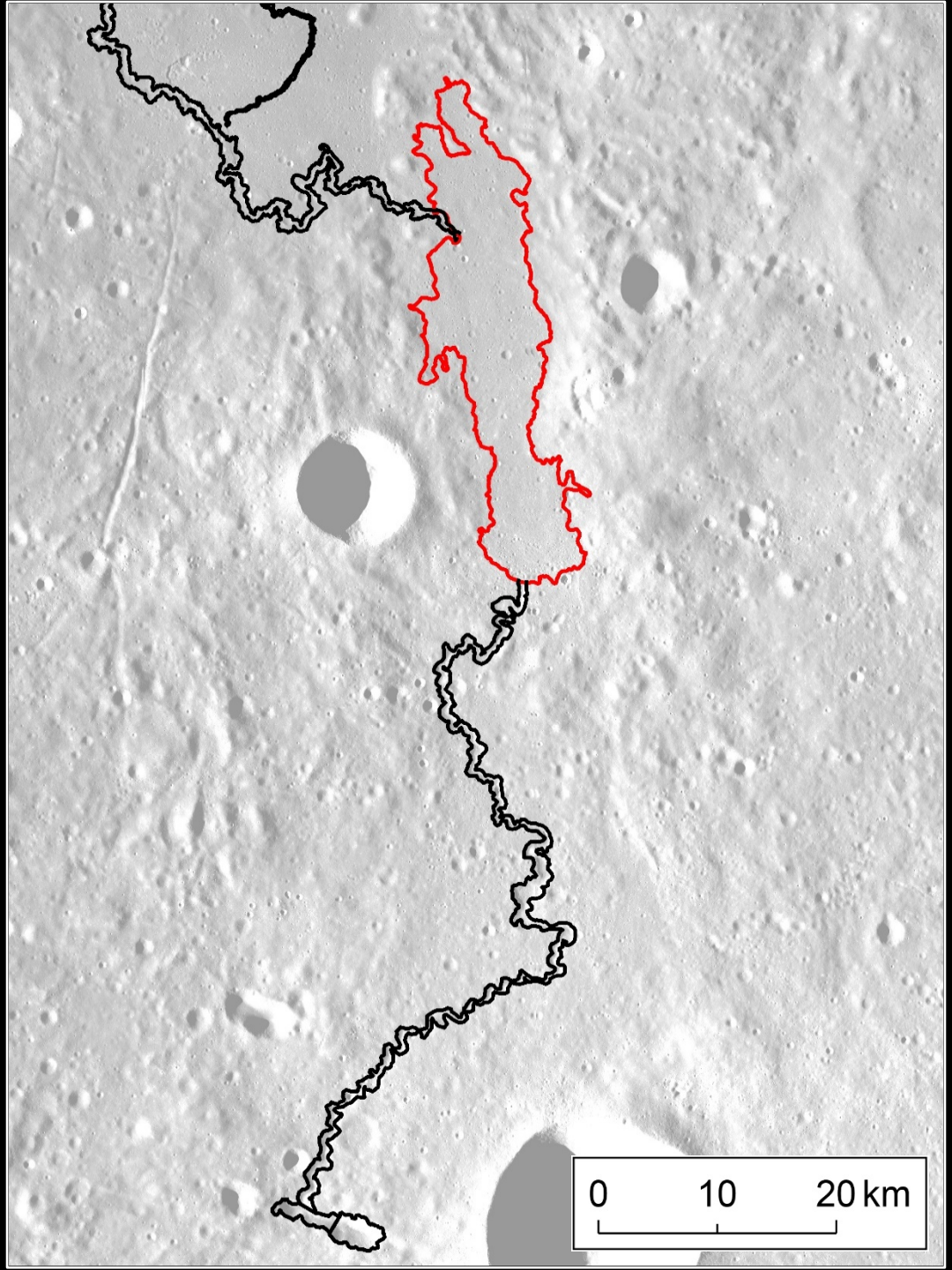
December, 1974 Kilauea Eruption

- December 31, 1974 (night).
  - Duration of ~6 hours.
- Areal Extent: 7.5 km^2.
- Volume: ~0.0143 km^3.
- Mean Eruption Flux: 662 m^3/s

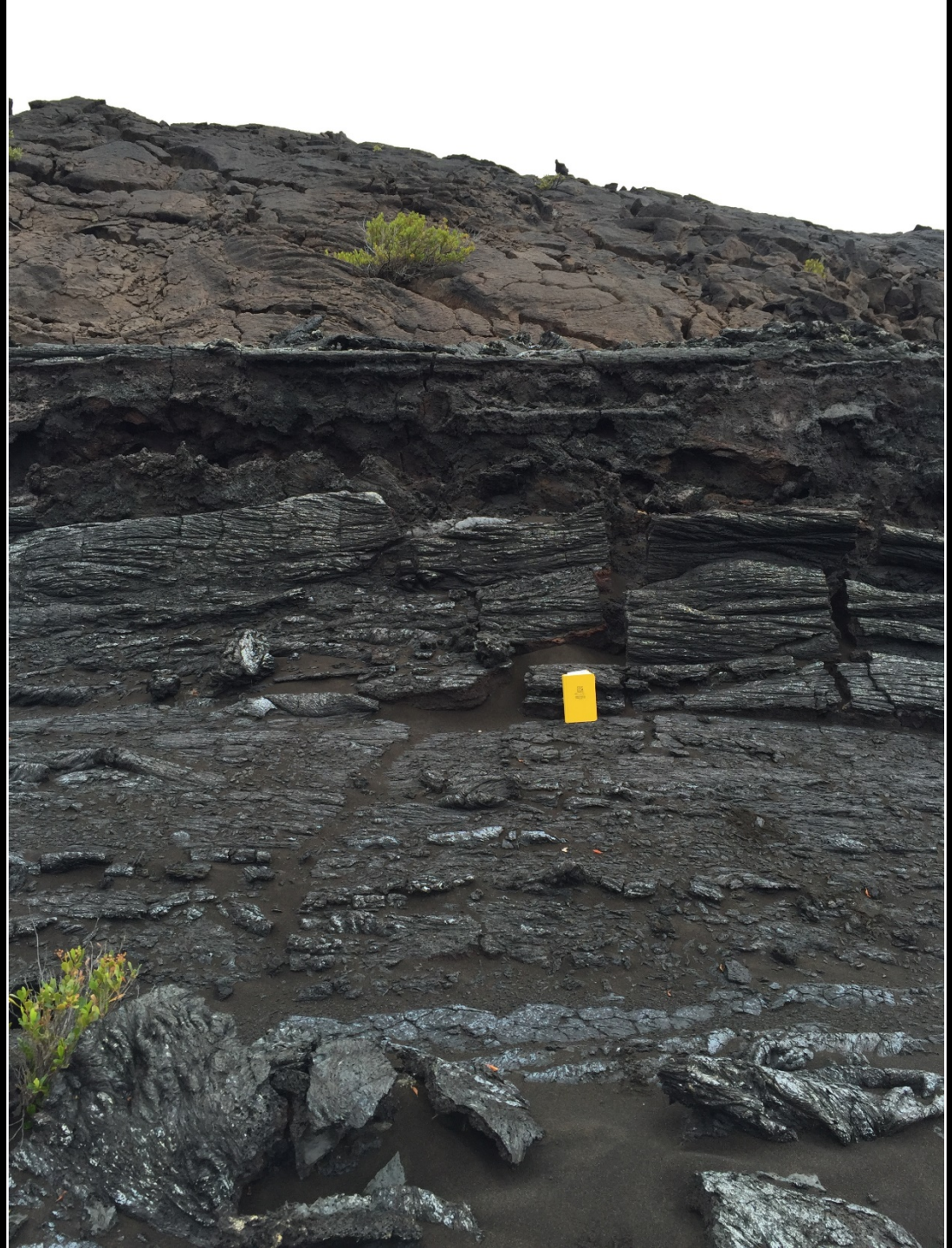


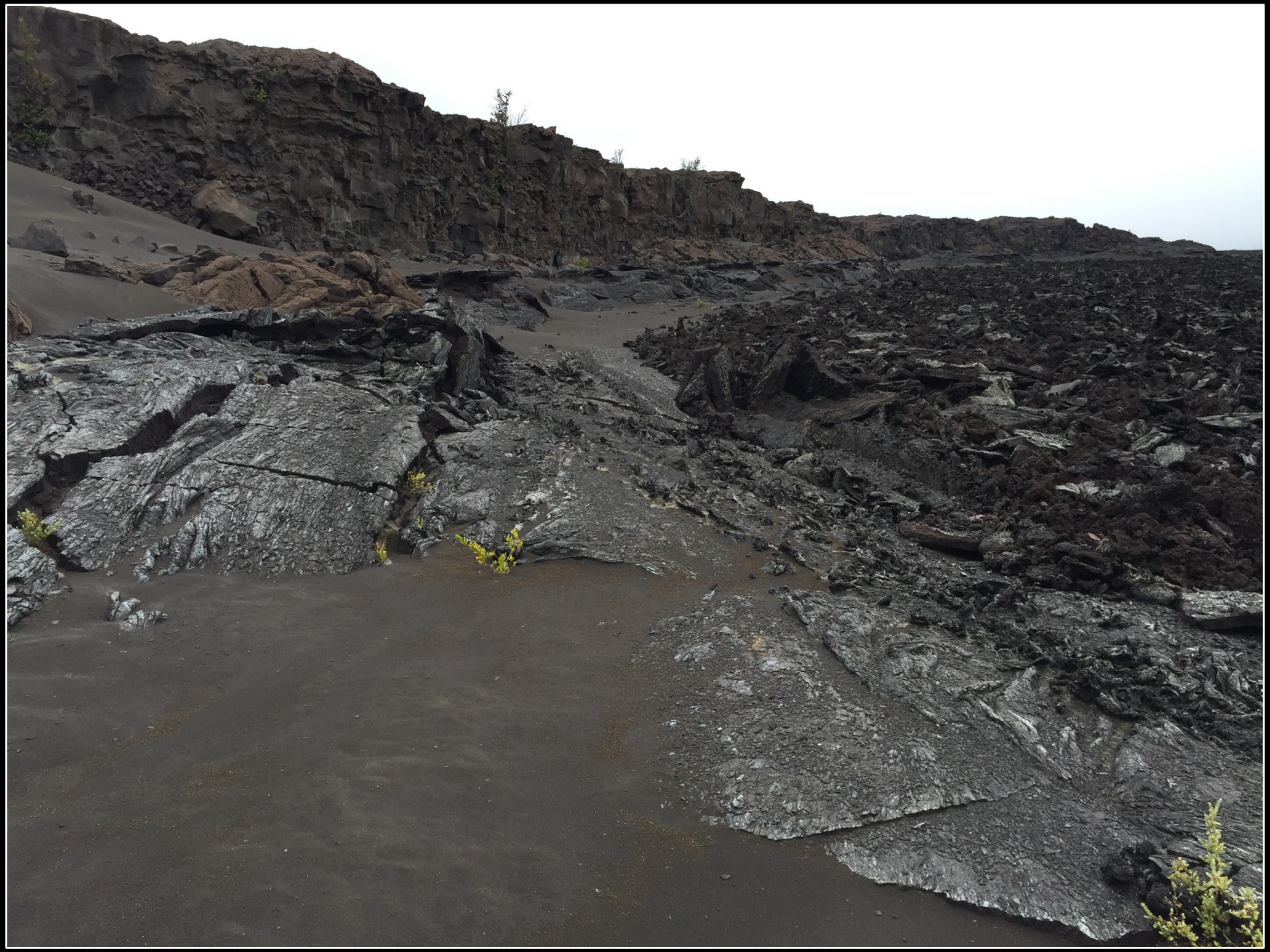
Photos of the July, 1974 eruption, courtesy of the US Geological Survey. No photos of the December, 1974 flow are available.

What feature separates the two channel segments?



Kaguya TC mosaic





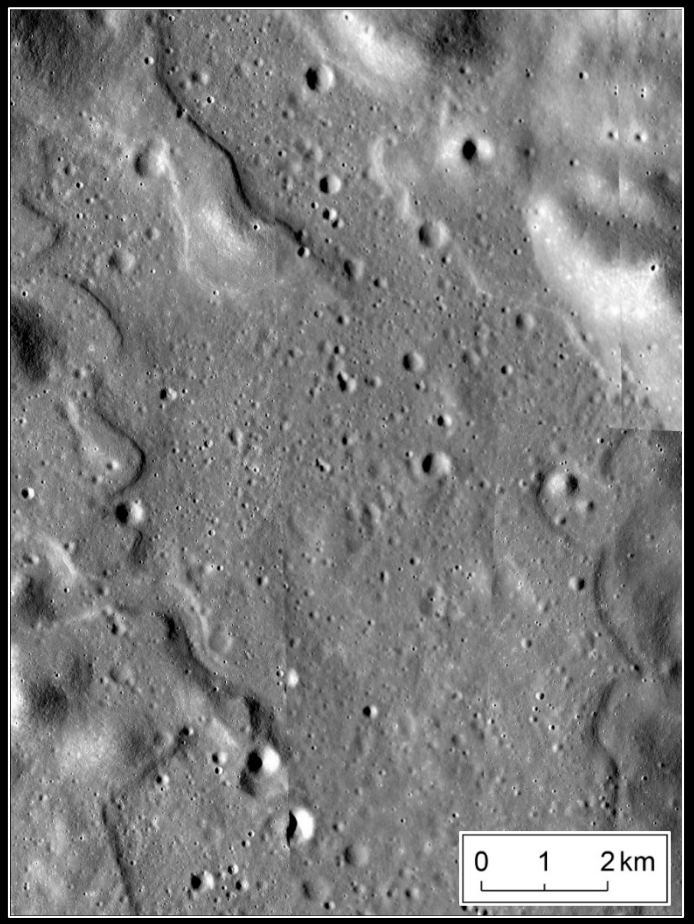
Conclusions 2: Mid-Channel Feature

Lava emplaced during the D1974 eruption formed a lava pond.

Marginal ridges represent high lava stands.

Marginal high stands form in the presence of a drained pond of lava.

Lava pond on the Moon!

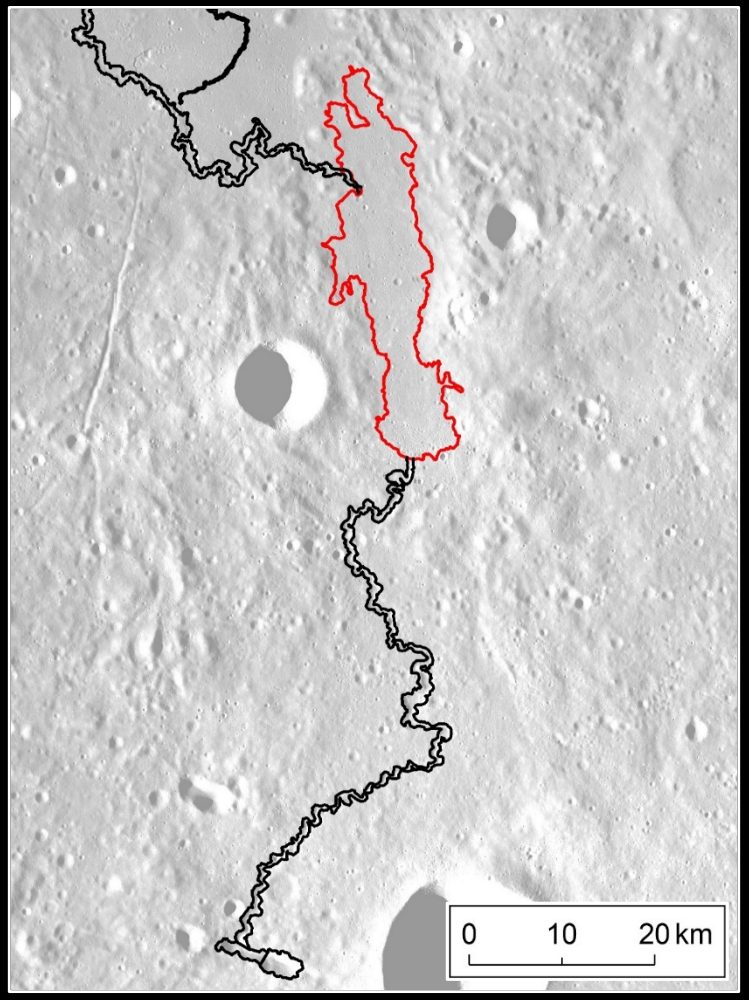


LROC NAC images and Kaguya TC mosaic

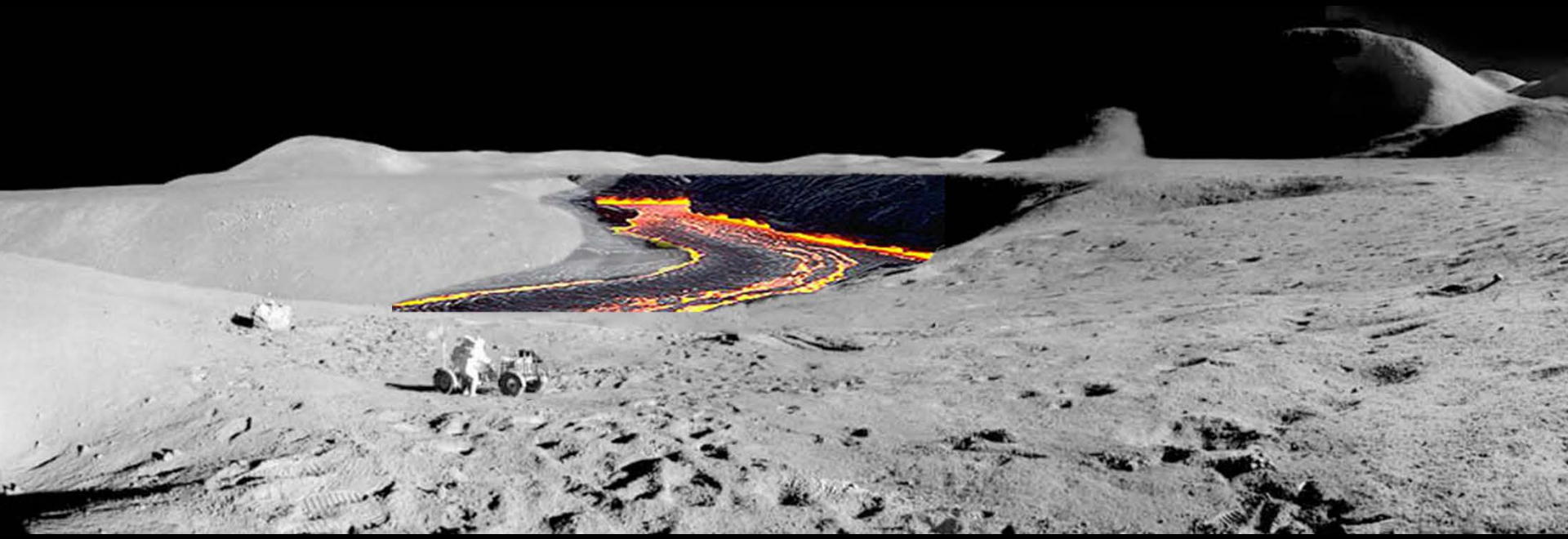
Conclusions: Formation of Rima Bode

- Duration of 10 – 22 days at peak eruption rates.
- Length, Width, Depth of Rima Bode:
  - Upper Channel: 109 km; 870 m; 100 m
  - Lower Channel: 139 km; 670 m; 75 m
- Areal Extent of Pond: 266 km^2.
- Lava Pond Volume: ~14 km^3.
- Peak Eruption Flux: 7,000 – 16,000 m^3/s

Eruption	Duration	Volume (km^3)	Flux (m^3/s)
December 1974	6 hours	0.0143	662 (mean)
Holuhraun	183 days	1.6	161 (mean)
Rima Bode	10-22 days	14	7,000-16,000 (peak)



Kaguya TC mosaic



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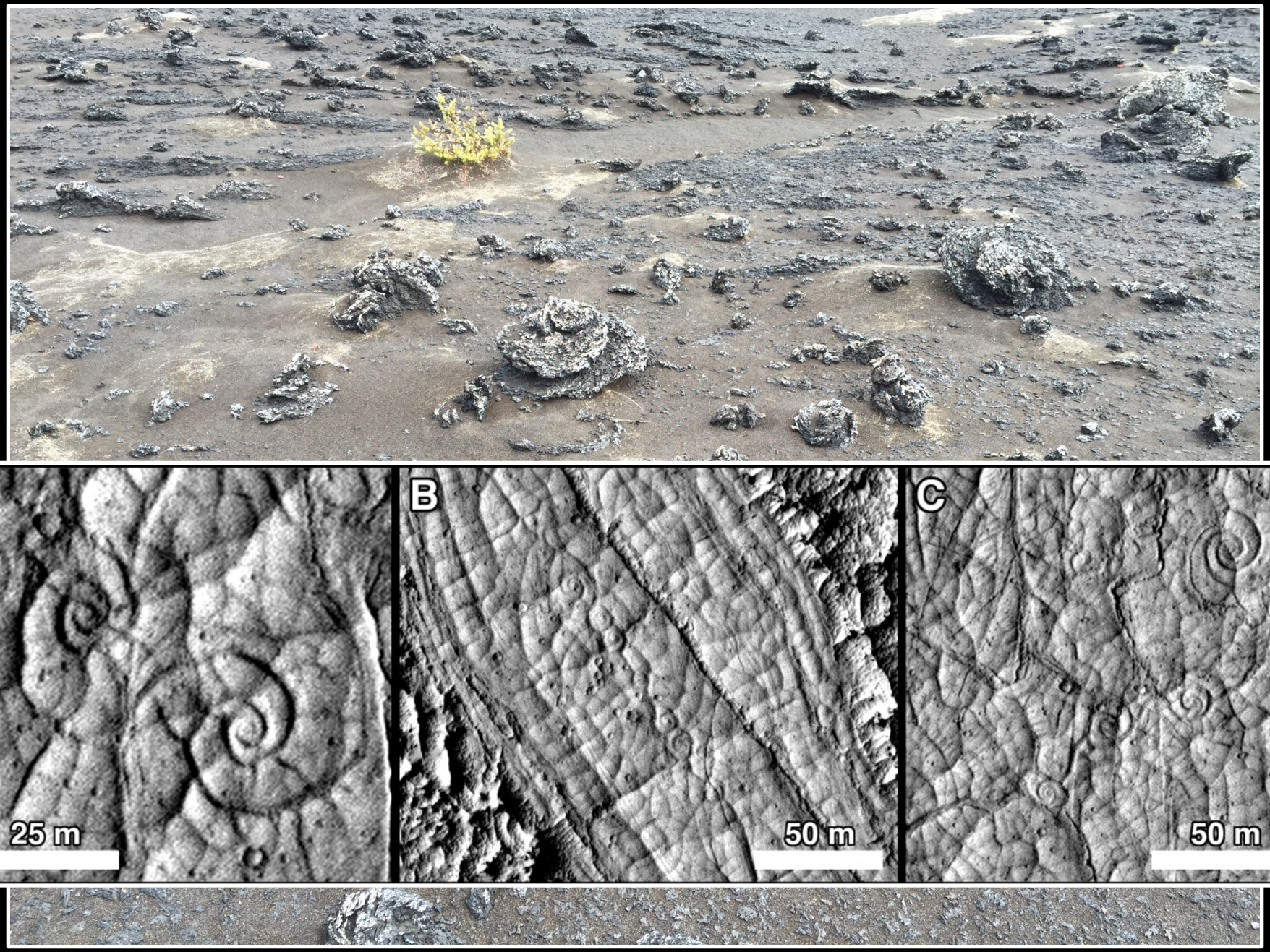

Ryan and Christensen, 2012